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Online COVID-19 High School Curriculum - Solon et al.

Supplement 1. Lesson Outline.

COVID-19 The Great Pandemic of 2020 Lesson Outline

Lesson Color-coding:

Activities: can be done solo or in a group

Background Information: students interact by answering questions

Introductory Unit

Lesson 0.1 How is SARS-CoV-2 impacting us here in the U.S.A.? In this lesson, you'll look at how Americans have been impacted by COVID-19, and delve into why we might be seeing such disparities in cases and deaths.	
Lesson objectives: By the end of the lesson, you will be able to… ● Explain the meaning of the various data points about COVID-19 such as cases, deaths, case-fatality ratio and deaths per 100,000. ● Navigate databases to look up and interpret data about the economic disparities among different demographics within the U.S. ● Make conclusions from the data about what may be causing COVID-19 disparities and understand the limitations of the conclusions.	
0.11 The stories of COVID-19	20 slides
You'll begin with a section that tells about the lives of some Americans who have died during this pandemic. Then you'll share your own COVID story. **The stories of COVID-19 PDF files**	
0.12 How are we doing today?	22 slides
Now, you'll put how the U.S. is faring during COVID-19 into the context of the world. You'll get familiar with an important database that tracks COVID-19 cases and deaths worldwide.	
0.13 COVID-19 in the U.S.	13 slides
In this section, you'll learn about U.S. demographics to answer the question – has COVID-19 affected us as we would have predicted?	
0.14 Why are there such disparities in the U.S.?	23 slides
Now you're going to dig deep into the economic and social conditions that may have led to such deep disparities in how different communities have experienced COVID-19. **Additional Document: 0.14 Table**	
0.15 The Meat-Processing Plant	16 slides

In this last section, you'll work through a case study that describes how working conditions can lead to specific vulnerabilities to COVID-19, and you'll use the same databases to design your own case study about a vulnerability that's of interest to you.
0.16 Apply your new knowledge!
Each lesson will end with a scientific or media article about the topic you have just covered. Now, you will be able to read the articles with a deeper understanding to evaluate their conclusions, and complete a reading worksheet. The first article can be found here. It talks about how systemic racism has also contributed to COVID-19 disparities. **Additional Document: 0.16 Reading Worksheet**

Lesson 0.2 How has COVID-19 impacted the world?

In this lesson, you'll look at how different countries have dealt with the challenge of COVID-19. In particular, how has a country's wealth impacted how it has handled the pandemic?

Lesson Objectives

By the end of the lesson, you will be able to…

- Explain the various factors that might influence how a country deals with a pandemic.
- Navigate databases to look up and interpret data about how COVID-19 has impacted various countries.
- Make conclusions from data about what may be causing COVID-19 disparities among different countries.

0.21 How has COVID-19 impacted other countries?	8 slides
In this first section, you'll go back to the Johns Hopkins database you used before to establish which countries have done best and which have done worst in responding to COVID-19.	
0.22 What economic factors influence how a country responds to a pandemic?	23 slides
For the next few sections, you're going to be following how several countries have faced the challenge of COVID-19. In this section, you'll use databases to establish the economic resources they had available, and then you'll make predictions as to how they fared. **Additional Document: 0.22 Global disparities worksheet**	
0.23 How well were countries prepared for a pandemic?	30 slides
There is one more piece of information we need to understand global disparities – how well prepared each country was to deal with a pandemic. You'll look at another database that ranked preparedness and then compare it with actual data on cases and deaths. How did the countries do?	
0.24 Why are there global disparities?	19 slides
Now you're going to work with another set of data, this time from the United Nations to try to understand the role of health care capacity in countries' responses to COVID-19. Where do the countries stand, and does their capacity fit in with their actual response?	
0.25 Apply your new knowledge!	

Read the news article found here that summarizes how all the pandemic simulation games carried out over the last few years failed to help the US manage COVID-19, & complete your reading worksheet. **Additional Document: 0.25 Reading worksheet**

Unit 1

Lesson 1.1 An Introduction to Viruses This lesson introduces the basic characteristics of viruses and the features of SARS-CoV-2 that are important for how it causes disease.	
Lesson objectives: By the end of the lesson, you will be able to… • Explain both sides of the debate about whether viruses are alive • Describe the different characteristics of non-enveloped and enveloped viruses. • Explain how SARS-CoV-2 infects cells using the specific structural features of the virus.	
1.11 What is a Pathogen?	15 slides
Pandemics, such as the current one causing COVID-19 (Coronavirus Infectious Disease- 2019), are caused by pathogens. You'll start by investigating what exactly pathogens are and explore the debate about whether viruses are living or non-living.	
1.12-1.13 How do viruses behave like parasites of living organisms?	13 slides
In this section, you'll explore how viruses can behave like cellular parasites. You'll calculate how big they are compared with eukaryotic (plant and animal) and prokaryotic (bacterial) cells. You will also become familiar with what structures they have that permit them to get inside cells and take them over.	
1.14-1.16 How does SARS-CoV-2 fit in?	11 slides
In this section, you'll focus on how SARS-CoV-2 behaves as a parasite, and in particular, on the important interaction between its envelope and the host cell that permits it to slip inside its host cells. You'll also make up a hand-washing song about SARS-CoV-2.	
1.17 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
1.18 Apply your new knowledge!	
Read one or both of the following articles. The first article is a New York Times Interactive that shows how scientists have found out in great detail what SARS-CoV-2 looks like. Find the link here . The second is a news article here about how soap affects the SARS-CoV-2 envelope and answer the questions on your worksheet. **Additional Document: 1.18 Reading Worksheet**	

Lesson 1.2 How Viruses Hijack Host Cells

This lesson explores how SARS-CoV-2 hijacks cells and makes them into a virus factory. It focuses on the errors SARS-CoV-2 makes as it replicates. These errors (mutations) are a powerful tool that allow us to investigate SARS-CoV-2 in many contexts, as we will see later.

Lesson objectives:

By the end of the lesson, you will be able to…

- Explain how enveloped viruses infect host cells. In particular, you will be able to explain how SARS-CoV-2, an RNA virus, infects a host cell.
- Interpret how mutations occur and how they can affect protein function.
- Distinguish between point mutations and recombination.
- Explain how SARS-CoV-2 corrects errors in replication.

1.21 Transcription and Translation	4 slides
First, a quick review of how cells use DNA to make RNA and proteins, using a web interactive. Make sure you understand these processes well!	
1.22 How do viruses hijack host cells?	13 slides
How viruses hijack cells depends on whether their genome is DNA or RNA. SARS-CoV-2 is an RNA virus, so in this section, you'll focus on how SARS-CoV-2 replicates inside a cell after infection.	
1.23 Errors in replication	25 slides
Every time SARS-CoV-2 replicates inside its host cell it makes random mistakes. These mistakes, or mutations, might produce a different version of SARS-CoV-2, or they might simply provide a 'footprint' of what SARS-CoV-2 was like in a specific time and place. They will be an important investigative tool going forward. You'll spend this section working with mutations so that by the end you'll have a thorough understanding of how they work.	
1.24 Let's play the mutation game!	7 slides
Here's the payoff! Will you be lucky (or unlucky) enough to produce the next pandemic-causing virus – SARS-CoV-3??	
1.25 Correcting errors	14 slides
Most viruses are stuck with their random mutations, but not SARS-CoV-2! In this last section, you will learn about the strategy SARS-CoV-2 has evolved to get rid of mutations as they happen. And you'll consider whether it's an advantage or not.	
1.26 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
1.27 Apply your new knowledge!	

Check out the following article about how SARS-CoV-2 is mutating and answer the questions on your worksheet. Find the link here.
Additional Document: 1.27 Reading Worksheet

Unit 2

Lesson 2.1 How did SARS-CoV-2 infect humans?

This lesson explores how the COVID-19 pandemic originated when SARS-CoV-2 first infected humans.

Lesson objectives:
By the end of the lesson, you will be able to…

- Define a reservoir and intermediate host in viral infections.
- Explain how the amino acid sequence of coronavirus spike proteins can be used to track virus transmission between animals.
- Infer how SARS-CoV-2 was transmitted across animal species based on the amino acid sequence of the spike protein in different viral strains.

2.11-2.12 How are infections transmitted? Animal to human transmission: Zoonosis	9 slides
How do humans become infected with a pathogen like SARS-CoV-2? You're going to start with a quick review of the ways different pathogens are transmitted and then zoom into transmission from animals, or zoonosis. You'll learn about how the horseshoe bat is critical to coronavirus infections.	
2.13 How did coronaviruses come to infect humans?	17 slides
This section takes a closer look at the animal reservoirs for coronaviruses and you'll explore the current puzzle about where exactly SARS-CoV-2 came from. Why do we even care? You'll find out!	
2.14 How does SARS-CoV-2 infect humans? The Spike protein	13 slides
Before you can use Spike protein mutations to track SARS-CoV-2 on its journey across species, you need to know which parts of the Spike protein will give you the best information. This section focuses on where you will be looking.	
2.15 Tracking zoonosis across the species barrier	25 slides
Now, you'll do an activity to try to figure out where SARS-CoV-2 went after bats – into civets, pangolins or both! This data was taken from very new studies; you will be the first to do this exercise.	
2.16 Where do pangolins fit in?	25 slides
Finding pangolins infected with SARS-CoV-2 has led to intense speculation that they could be the intermediary host. You'll apply your new skills at mutation analysis to deduce whether that's possible.	
2.17 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	

2.18 Apply your new knowledge!	
Read the following news article about the search for an intermediate host for SARS-CoV-2 and answer the questions on your worksheet. You can find the link here. **Additional Document: 2.18 Reading Worksheet**	

Lesson 2.2 How did COVID-19 travel around the world? This lesson focuses on how phylogenetic analysis of different SARS-CoV-2 isolates helps us understand how the COVID-19 pandemic spread around the world.	
Lesson objectives: By the end of the lesson, you will be able to… ● Describe what a viral isolate is. ● Interpret a phylogenetic tree to determine a virus lineage. ● Explain how phylogenetic trees can be used to track viral spread.	
2.21 Global travel in the age of COVID-19	13 slides
International travel is so easy that epidemics can rapidly become pandemics, which are more widespread. COVID-19 was first identified in Wuhan, China, but within months had traveled all over the world. In this section, you'll explore just how easy it is to get from Wuhan to practically anywhere in the world.	
2.22 Tracking infectious disease spread	10 slides
Tracking SARS-CoV-2 spread across the world can be done using phylogenetic analysis – sequencing virus isolates collected in different places at different times. In this section, you'll learn what phylogenetic analysis means and how to set up a phylogenetic tree.	
2.23 Tracking SARS-CoV-2 spread	30 slides
Now that you're able to interpret phylogenetic trees, you'll work with a database to determine how SARS-CoV-2 came to Austria. Take a break after slide 18!	
2.24. Using clades to track SARS-CoV-2 around the world	14 slides
Virus isolates that descend from a common ancestor can be grouped into clades, then clade maps can be used to trace how viruses evolve globally. Now, you'll use the clade map being developed in real time by Nextstrain.org to trace how SARS-CoV-2 traveled around the world.	
2.25. How did SARS-CoV-2 come to the U.S.?	21 slides
You'll continue to use the clade map, this time to figure out how SARS-CoV-2 came to the U.S. Did it just come from China, and did stopping flights into the U.S. help curtail its arrival at all?	
2.26 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
2.27 Apply your new knowledge!	

Study the New York Times interactive infographic here to understand how and when SARS-CoV-2 came to the U.S. and traveled within its borders. Also highly recommended - a Washington Post infographic that shows how sequencing the virus genome can be used to trace the spread of infections. Find it here Complete your reading worksheet.
Additional Document: 2.27 Reading Worksheet

Lesson 2.3 How is SARS-CoV-2 transmitted between people?
This lesson focuses on virus transmission from person to person, particularly through the air. It evaluates risk factors and describes ways to minimize infection.

Lesson objectives:
By the end of the lesson, you will be able to…

- Explain how SARS-CoV-2 can be transmitted through the air and through fomites.
- Differentiate between droplets and aerosols.
- Analyze data and make conclusions about where SARS-CoV-2 is most likely to be found in the environment indoors and in outdoor public spaces.
- Make recommendations about how businesses could operate while preventing SARS-CoV-2 transmission among patrons and employees.

2.31-2.32 Routes of Pathogen Transmission	40 slides

This first section sets the stage by reviewing how pathogens are transmitted from person to person. Then, in the second part, you'll learn how an argument about the nature of droplets vs. aerosols has impeded our understanding about SARS-CoV-2 transmission.
You can take a break after slide 16!

2.33 SARS-CoV-2 and aerosol transmission	26 slides

Finding out that SARS-CoV-2 travels in aerosols as well as droplets was a game-changer in terms of understanding why it is so infectious. In this section, you'll work through a couple of the papers published in spring 2020 that provided this critical information.

2.34 Ways to Minimize Transmission	18 slides

Realizing that SARS-CoV-2 is highly infectious and that it can be transmitted through aerosols makes it imperative that we act to minimize transmission. In this section, you'll evaluate different methods and their limitations.

2.35 Back to work!	20 slides

In this last section, you'll examine another risk factor for SARS-CoV-2 infection – inadequate ventilation. First, you'll examine two of the case studies that provided this information, then you'll evaluate several scenarios in which it leads to infection and what can be done to minimize risk. Finally, you'll bring it all together by constructing your own scenario and recommendations, based on your own experiences.

2.36 Vocab review	

Review vocabulary from the lesson by matching words and definitions.

2.37 Apply your new knowledge!	
Read the following news article about how being in isolation for a long period of time is hard to sustain and complete your reading worksheet.The link is here. **Additional Document: 2.37 Reading Worksheet**	

Lesson 2.4 When is SARS-CoV-2 infectious and how can we tell?
This lesson focuses on how we can know whether a person infected with SARS-CoV-2 will pass it on, and how we can tell we've been infected.

Lesson objectives:
By the end of the lesson, you will be able to…

- Describe how the Minimal Infectious Dose (MID) determines if a successful infection will occur.
- Explain the importance of the latent and infectious periods in how we can control whether an infection is transmitted.
- Consider multiple pieces of information to determine how likely it is that a person will be infected with SARS-CoV-2 in various scenarios.
- Explain how testing for SARS-CoV-2 is carried out, and its limitations.

2.41 How much SARS-CoV-2 is needed to cause an infection?	18 slides
A key question in dealing with SARS-CoV-2 infectivity is how much virus is needed to cause disease. This section focuses on how the minimal infectious dose is measured and the limitations of the measurement. Will 'humanized' mice be the solution?	
2.42 How does time of exposure impact infection with SARS-CoV-2?	9 slides
The MID is not the only factor that determines whether an infection will be successful. The other ingredient is time. In this short section, you'll evaluate scenarios that illustrate how time affects infection, and also learn about the impact superspreaders can have.	
2.43 When is an infected person infectious?	41 slides
A key question in infection control is how long after infection it takes to become infectious, and when does infection disappear? Now, you'll learn about the different stages of infection and why asymptomatic transmission presents such a challenge to infection control. You can take a break after slide 18!	
2.44 How likely am I to be infectious?	9 slides
You've learned that how likely an infected person will pass on the infection depends on how much virus they transmit and when they are infectious. In this short section, you'll evaluate a few scenarios as to whether you'd be likely to infect others.	
2.45 How can I know if I'm infected?	21 slides
Testing for the presence of SARS-CoV-2 is the only way to know for sure that infection has occurred. But are tests reliable? Here you'll learn about how tests for SARS-CoV-2 work. You'll review PCR and explore the limitations of testing.	

2.46 Asymptomatic transmission: a case study	10 slides
Asymptomatic transmission is a major public health challenge that has been very controversial. Here you'll explore the first case study that was published to suggest it would be a big factor in the COVID-19 pandemic.	
2.47 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
2.48 Apply your new knowledge!	
Read the following news article about how asymptomatic transmission of SARS-CoV-2 was originally missed and answer the questions on your reading worksheet. The link is here. **Additional Document: 2.48 Reading Worksheet**	

Unit 3

Lesson 3.1 How does SARS-CoV-2 cause disease? This lesson focuses on how SARS-CoV-2 infects cells by attaching to its ACE2 receptor, the important role that ACE2 normally plays in homeostasis, and what happens when SARS-CoV-2 interferes with that function.	
Lesson objectives: By the end of the lesson, you will be able to… • Explain the role of epithelial cells in SARS-CoV-2 infections. • Describe the peptides and enzymes in the angiotensin converting system and predict symptoms based on alterations in the levels of the system's components. • Explain ACE2 levels in aging and disease and how this might affect SARS-CoV-2 symptoms and outcomes.	
3.11 Where viral infections cause symptoms	10 slides
How can we account for the symptoms that viral infection causes? In this short introductory section, you'll review why different infections cause different symptoms.	
3.12 The importance of epithelial cells in viral infections	10 slides
The outside of the body is swarming with pathogens, while the inside is sterile. In this section, you'll learn about how important epithelial cells are in forming a barrier to protect the inside from the outside.	
3.13 How are epithelial cells infected with SARS-CoV-2?	12 slides
Recall that the receptor for SARS-CoV-2 (and SARS-CoV-1) is called ACE2. Here you'll learn where ACE2 is located and why it's important, as well as what happens when SARS-CoV-2 infects epithelial cells.	
3.14 How does ACE2 affect homeostasis?	23 slides

You've learned that SARS-CoV-2's receptor, ACE2, is located throughout the body, and plays a critical role in homeostasis. How? Here you'll explore how ACE2 works, and what goes wrong when it's inactivated.	
3.15 How does SARS-CoV-2 affect ACE2?	24 slides
ACE2 is critically important for blood pressure homeostasis, but what happens after SARS-CoV-2 infection? Here you'll learn about how SARS-CoV-2 inactivates ACE2, and what happens if an infection occurs when ACE2 is already not working properly.	
3.16 Why controlling Angiotensin II is important	18 slides
In this section, you'll learn about how drugs have been used to control the high levels of Angiotensin II found in disease. You'll consider and answer the question: "If I'm taking these drugs, am I more likely to have a bad outcome in COVID-19?"	
3.17 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
3.18 Apply your new knowledge!	
Read the following news article about ACE2's role in COVID-19 and answer the questions on your reading worksheet. The link is here. **Additional Document: 3.18 Reading Worksheet**	

Lesson 3.2 SARS-CoV-2 and the immune system This lesson focuses on how the innate immune system contributes to the symptoms encountered in COVID-19.	
Lesson objectives: By the end of the lesson, you will be able to… • Explain how the innate immune system responds to viruses • Explain how SARS-CoV-2 interferes with the innate immune system • Explain how a cytokine storm causes symptoms of COVID-19	
3.21 What causes COVID-19 symptoms?	8 slides
Only some of the symptoms of COVID-19 are caused by the virus itself and its receptor. The immune system response also has serious effects. In this section you'll find out how!	
3.22 How COVID-19 Kills: Acute Respiratory Distress Syndrome (ARDS)	17 slides
ARDS is one of the most severe and often fatal symptoms of COVID-19. Here you'll learn how ARDS occurs through a combination of tissue damage and immune response.	
3.23 Symptoms of immune system activation	19 slides

You've looked at how the innate immune system contributes to ARDS, but in fact, it is responsible for many symptoms of infection. In this section, you'll learn how the process of inflammation is key to many of those symptoms, and how SARS-CoV-2 affects many other organs.	
3.24 How the innate immune system responds to SARS-CoV-2	34 slides
In the last section, you learned that inflammation is a normal immune system response to infection. Now, you're going to learn how the innate immune system responds to SARS-CoV-2. You can take a break after slide 22!	
3.25 The virus and the host cell dance!	32 slides
You've learned how the innate immune system rapidly swings into action to eliminate a SARS-CoV-2 infection. In this section, you will learn how the defense sometimes fails. In a process we still don't fully understand, the immune system fails to shut itself off and the tissue damage that results often leads to death. You can take a break after slide 23!	
3.26 From SARS-CoV-2's Point of View	2 slides
Here's an opportunity to get creative with your new knowledge! **Additional Document: 3.26 Worksheet**	
3.27 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
3.28 Apply your new knowledge!	
Check out the following article about how young people are experiencing cytokine storms after SARS-CoV-2 infection and answer the questions on your reading worksheet. You can find the link here. **Additional Document: 3.28 Reading Worksheet**	

Lesson 3.3 Is COVID-19 only a lung disease?

This lesson focuses on how COVID-19 affects multiple organ systems and has chronic effects.

Lesson objectives:

By the end of the lesson, you will be able to…

- Describe the wide-ranging symptoms of SARS-CoV-2 on impacted organs, and how COVID-19 has chronic effects.
- Describe the role of helper proteases in SARS-CoV-2 infection and make predictions about whether SARS-CoV-2 will be able to infect certain types of cells.
- Design an experiment to determine whether or not SARS-CoV-2 infects certain types of cells.

3.31 COVID-19 Symptoms	6 slides
What are the symptoms of COVID-19? Prepare to be surprised!	
3.32 Why does SARS-CoV-2 infection cause such broad effects?	24 slides

You've learned how COVID-19 is caused by a combination of ACE2 effects and the immune response to viral infections. Here you'll focus on the symptoms of COVID-19 that indicate it's a multi-organ disease.	
3.33 COVID-19 as a chronic disease	17 slides
COVID-19 is often compared to influenza. But while you can catch influenza more than once, it isn't a chronic disease. COVID-19 is a chronic disease, frequently in younger patients. Here you'll learn how.	
3.34 Is ACE2 enough for efficient infection?	14 slides
You've learned that cells need to have the ACE2 receptor to be vulnerable to SARS-CoV-2, but that's not the whole story. In this section, you'll learn about the extra help SARS-CoV-2 needs to infect efficiently and what that means for which tissues are vulnerable.	
3.35 The $64K Question! Design an Experiment	30 slides
In this section, you're going to design and experiment to answer the $64K question. What is the $64K question? Let's find out! You can take a break after slide 16!.	
3.36 Case Studies	5 slides
You'll end this section exploring some case studies about the unusual symptoms associated with COVID-19. Choose two of the three and answer the questions on the doc your teacher will provide. **Additional Document: 3.36 Case Studies Worksheet**	
3.37 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
3.38 Apply your new knowledge!	
Read the following news article about how obesity makes COVID-19 outcomes in young people worse, and complete your reading worksheet. You can find the article here. **Additional Document: 3.38 Reading Worksheet**	

Unit 4

Lesson 4.1 How can COVID-19 be controlled? This lesson focuses on COVID-19 as a pandemic, how an infection spreads, how spread can be measured, and how public health measures can control a pandemic.
Lesson objectives: By the end of the lesson, you will be able to… • Describe R_0 and its significance in transmission of infection. • Explain herd immunity and why we need to achieve it to control a pandemic.

• Describe and evaluate the resources we have available to control pandemics.	
4.11 How are infectious diseases spread?	15 slides
Here you'll learn why knowing how an infectious disease spreads is critical for managing pandemics.	
4.12 Measuring how infectious diseases spread - the R number	24 slides
Here you'll learn about how we can determine a critical measurement for understanding disease spread.	
4.13 Measuring how infectious diseases spread - dispersibility	24 slides
SARS-CoV-2 infections spread differently than many other infectious diseases. Here you'll learn about the importance of superspreaders in how COVID-19 spreads, and what an 80/20 strategy for dealing with infection is.	
4.14 Detecting transmission	24 slides
In this section, you'll focus on the public health strategies we use to detect transmission of infectious diseases and what will work best for COVID-19.	
4.15 How public health measures can control spread	30 slides
In this section, you'll focus on the public health strategies we use to control transmission of infectious disease. You can take a break after slide 15!	
4.16 How decreased susceptibility prevents spread	27 slides
In this section, you'll focus on the public health strategies we use to control transmission of infectious disease.	
4.17 Eliminating COVID-19 - timing is everything!	10 slides
In this last section, you will address the question of whether the outcome of the COVID-19 pandemic would have been significantly altered if we had started to respond sooner.	
4.18 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
4.19 Apply your new knowledge!	
Choose one (or both) of the articles on this slide or the next slide to read. Read the following article from Atlantic magazine about how COVID-19 got out of hand.The link is here. Alternatively, read the following article from Nature about current knowledge about how well masks work. The link is here. **Additional Document: 4.19 Reading Worksheet**	

Lesson 4.2 How does the immune system get rid of SARS-CoV-2? This lesson focuses on how adaptive immunity clears SARS-CoV-2 infections, and how it can be harnessed to produce vaccines.	
Lesson objectives: By the end of the lesson, you will be able to… • Describe how the adaptive immune system deals with viral infections. • Explain how vaccines use immune memory to combat infection. • Describe how a vaccine is designed and explain what makes a good vaccine.	
4.21 How the innate and adaptive immune systems work together	32 slides
Here you'll learn about the adaptive immune system to complete your understanding about how the immune system vanquishes infections. You can take a break after slide 18!	
4.22 How does the adaptive immune system deal with viral infections?	24 slides
Now, you're going to explore how the cells of the adaptive immune system coordinate to finally get rid of a virus infection.	
4.23 How does the adaptive immune system remember virus infections?	9 slides
In this section, you'll explore how the adaptive immune system retains a memory of previous infections, so it can respond more quickly if it encounters them again.	
4.24 Harnessing the immune system against SARS-CoV-2 - building a vaccine	28 slides
It turns out our immune system already has all the components needed to eliminate SARS-CoV-2 infections - if we're lucky. In this section, you'll learn about the challenges of building a good vaccine.	
4.25 How good must a vaccine be?	26 slides
In this section, you'll learn how to figure out how we achieve herd immunity with vaccines, and will use your calculations to make predictions about whether we'll be able to achieve herd immunity with a COVID-19 vaccine.	
4.26 How safe must a vaccine be?	28 slides
Here you'll learn about the effects, wanted and unwanted, that vaccines have, and why public confidence matters if a vaccine program is to work.	
4.27 Testing a COVID-19 vaccine	26 slides
In this last section, you'll apply what you've learned to work with some case studies that illustrate the challenges in designing effective vaccine trials.	
4.28 Vocab review	
Review vocabulary from the lesson by matching words and definitions.	
4.29 Apply your new knowledge!	

Choose one (or both) of the articles to read. Read the following news article from the National Institutes of Health Director Dr. Francis Collins about a surprising finding regarding immunity to COVID-19. You can find the link here.. Alternatively, read the following Washington Post article that keeps us up-to-date on how the vaccine trials are going. You can find the link here.
Additional Document: 4.29 Reading Worksheet

Lesson 4.3 Should schools stay open or close in response to a spike in COVID-19 cases? A multiple stakeholder scenario

In this last lesson, you will have an opportunity to understand the many different viewpoints and complicated decisions that cities and towns need to make when determining whether or not students should go to school in-person, or take part in remote learning, in response to COVID-19 spikes in infection. You will be given the backstory (see below) of the town of Smallville, USA, where the Mayor needs to make a plan for how to proceed with teaching and learning, and is holding a town meeting to hear perspectives from different stakeholders. Individually, in a pair or group of three, depending on the size of your class, you will be given a different stakeholder role's perspective. You will then come up with a solution to suggest to the Mayor about what to do taking in account what you have learned about SARS-CoV-2's biology and public health approaches. Each person or group will present their stakeholder's story and their solution at the town meeting (class discussion). The goal is for the entire class to come to consensus about what the Mayor's plan should be.

Lesson objectives:
By the end of the lesson, you will be able to…

- Come up with a solution for how to close or keep schools open safely taking into account multiple different perspectives and challenges.
- Apply what you know about the biology of SARS-CoV-2 to create a solution with your peers.